[0091] Examples of haptics provided by the image haptics providing apparatuses and methods according to the above-described embodiments of the present invention will be explained with reference to **FIGS. 16 through 18**.

[0092] **FIG. 16** is a graph illustrating a waveform of current supplied to the electromagnetic cells. The vertical axis represents current i supplied to the electromagnetic cells and the horizontal axis represents spatial positions of the electromagnetic cells.

[0093] For example, to provide material feedback of a sheet of paper to the user as haptics of an image, current, which changes in a pattern of a sine waveform according to spatial positions of the electromagnetic cells as shown in **FIG. 16**, may be supplied as upper and lower control signals to the upper magnetic force unit **112** and the lower magnetic force unit **114**. That is, when current having such a sine waveform as shown in **FIG. 16** according to positions of electromagnetic cells is supplied, the user can feel haptics as if he or she actually touches a sheet of paper.

[0094] Part (a) of **FIG. 17** is a graph illustrating a waveform of another current supplied to the electromagnetic cells. The vertical axis represents spatial positions of the electromagnetic cells, and the horizontal axis represents current i supplied to the electromagnetic cells. Part (b) of **FIG. 17** is a diagram illustrating an example of a pull-down menu.

[0095] For example, if such a menu as shown in part (b) of **FIG. 17** is displayed on the image unit and current having a square waveform as shown in part (a) of **FIG. 17** according to positions of electromagnetic cells is supplied to the coils, the user can feel slipperiness feedback between adjacent menu items and protrusion feedback from the menu items when sequentially touching the menu items shown in part (b) of **FIG. 17** downward.

[0096] **FIG. 18** is a graph illustrating a waveform of magnetic forces caused from the electromagnetic cells. The horizontal axis represents spatial positions of the electromagnetic cells, and the vertical axis represents magnetic forces caused from the electromagnetic cells.

[0097] For example, when the electromagnetic cells generate magnetic forces according to their spatial positions as shown in **FIG. 18**, the user can feel concavo-convex feedback when crossing a dot or a line, or when crossing a section.

[0098] **FIG. 19** is a diagram for explaining examples in which concavo-convex feedback is used. The examples include images **270** and **274** used for recognizing characters, and images **272** and **276** used for recognizing icons.

[0099] The user can feel tactile feedback and recognize the kinds of characters in the displayed images **270** and **274** shown in **FIG. 19** using concavo-convex feedback obtained by magnetic forces as shown in **FIG. 18**. To this end, the minimum horizontal size and the minimum vertical size of each consonant may be set to 4.2 mm and 3.8 mm, respectively.

[0100] In addition, the user can tell an icon from a non-icon in the displayed images **272** and **276** shown in **FIG. 19** using the concavo-convex feedback obtained by the magnetic forces as shown in **FIG. 18**. To this end, the horizontal size and the vertical size of each icon may be set to 6.9 mm,

[0101] When applied to a field where an icon is selected through a touch screen, in the above-described embodiments of the present invention, such selection causes the icon and a non-icon to provide different haptics, such that the user can more easily identify the icon. Further, when applied to a field where alphanumeric characters are selected through a touch screen, the present invention causes the alphanumeric characters to provide different haptics on a keyboard displayed through the touch screen, such that the user can more easily and exactly identify the alphanumeric characters than when the user types the characters by touching.

[0102] The above-described embodiments of image haptics providing apparatuses and methods can provide haptics to a user directly in real time through an image unit, differently from a conventional method which indirectly provides haptics of an image to a user using a mouse or the like. Also, the image haptics providing apparatuses and methods can provide the haptics of the image to the user without an interface device and an actuator. Since haptics of a menu or an icon are different from haptics of a background of the menu or the icon in a field where the menu or the icon is selected through a touch screen, the user can directly feel the haptics of the menu or the icon and can more correctly select the menu or the icon with confidence and braking power without a slip, thereby reducing errors in selection. Besides, the user can directly feel haptics of an image by touching the displayed image using his or her body part or a touch member, and can be provided with both visual and haptic effects through one image unit.

[0103] Although a few embodiments of the present invention have been shown and described, the present invention is not limited to the described embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to these embodiments without departing from the principles and spirit of the invention, the scope of which is defined by the claims and their equivalents.

What is claimed is:

1. An apparatus for providing haptics of an image displayed through an image unit, comprising:

   a touch unit checking whether a user has touched a portion of the displayed image, and searching for a position of the portion when the user touches the portion; and

   a magnetic force changing unit changing magnetic forces in response to haptic information corresponding to the position and expressing the changed magnetic forces through the image unit,

   wherein haptics of the portion are provided through the change of the expressed magnetic forces.

2. The apparatus of claim 1, further comprising a haptic information generating unit generating information on haptics of an image to be displayed as the haptic information.

3. The apparatus of claim 2, wherein the haptic information generating unit includes:

   a haptics numerically calculating unit dividing the image to be displayed into a plurality of regions and numerically calculating haptics of each region; and

   a storing unit storing numerically calculated results of each region and outputting the stored results as the haptic information.